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(71) Applicant *(for all designated States except US)*: ALLGON AB [SE/SE]; Box 500, S-184 25 Åkersberga (SE).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)* : SALDELL, Ulf [SE/SE]; Kvarnåsvägen 2, S-184 51 Österskär (SE).

(74) Agents: MODIN, Jan et al.; Axel Ehrners Patentbyrå AB, Box 10316, S-100 55 Stockholm (SE).

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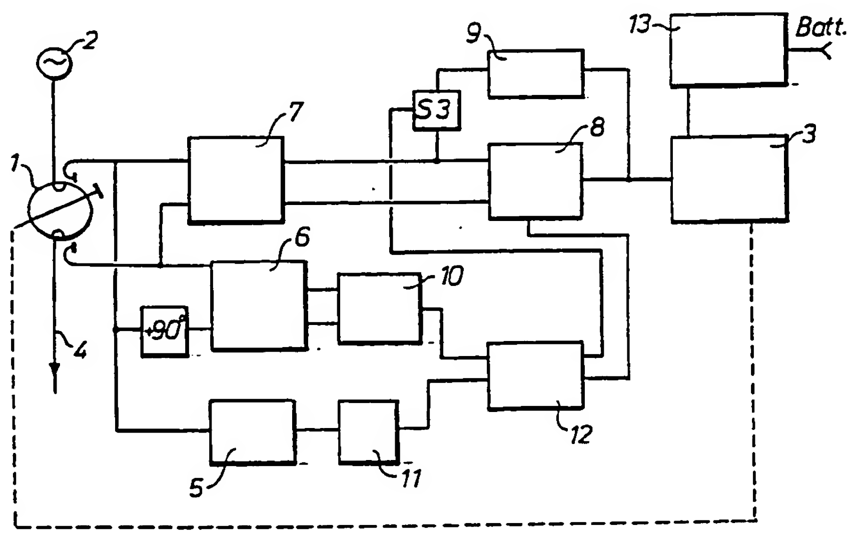

(57) Abstract

There is here described a method and apparatus in mobile telephone system including base stations with a plurality of resonance modules, for separately adjusting each resonance module to its own frequency for receiving and expedating telephone signals at this frequency. In each resonance module a tuning means is controlled to its given resonance position in relation to the frequency of the incoming signal. The tuning means (2) of the resonance module are operated by an electronic mechanical drive means which is connected for obtaining drive voltage via a phase comparison means (7), which is formed such that the drive voltage passes solely when two input signals to the phase comparison means differ in phase. A signal line for a branched signal from an input signal to the resonance module, as well as a signal line from the output of the resonance module are connected to the phase comparison means. When both signals are in phase, the drive voltage is zero, the drive means then being stationary and the tuning means (2) keeps the resonance module adjusted in resonance to the input signal. An adjusting means (3) is also described for controlling the tuning means (2).

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A METHOD AND A DEVICE PERTAINING TO AN ELECTRO-MECHANICALLY CONTROLLED RESONANCE MODULE.

The present invention relates to a method, in mobile telephone system including base stations with a plurality of resonance modules (cavaties), for separately adjusting each resonace module to its own frequency for receiving and expediting telephone signals on this frequency, a tuning means in each module being guided to its given resonance state in relation to the frequency of the incoming signal. The invention also relates to apparatus for carrying out the method, as well as adjusting means for guiding the tuning means.

In such mobile telephone systems it is already known to arrange a plurality of resonance modules at the base stations, each of these module being tunable to a specific frequency. Earlier, the adjustment of the resonance modules was done manually, although there are also known systems for carrying out this automaticly. The present invention has the object of improving the automatic adjustment and, inter alia, there is achieved with the invention that a part of the switching circuit functions as a selevtive amplitude detector, resulting in that the apparatus will not be responsive to signals from neighbouring channels. With the aid of the circuits and the electromechanical adjusting means there is achieved a very rapid setting and fine adjustment of the resonance module in question. The rapidity of the setting means is in itself necessary in telephone systems, and was perhapse afforded by earlier known setting means as well, but in addition the setting means in accordance with the present invention is much more reliable and has a long life.

The characterizing features of the present invention are apparent from the following claims, and the invention will now be described in more detail and with reference to the acompanying Figures, where,

Fig. 1 is a block diagram of units included in the system for the adjustment of the resonace modules.

Fig. 2 is a terminal drawing of three detectors included in the system.

Fig. 3 is a graph of the phase setting.

Fig. 4 is a terminal drawing for the error amplifier.

Fig. 5 is a terminal drawing of the error amplifier signal paths when the transmitter is shot down.

Fig. 6 illustrates the signal paths for the error amplifier during searching.

Fig. 7 is a terminal drawing of the error amplifier signal paths when the system is looked.

Fig. 8 is a terminal drawing for switching lodgic.

Fig. 9 is a cross section through a resonance module and adjusting means in accordance within the invention.

Fig. 10 schematicly illustrates the system in accordance with the invention.

The method of controlling the setting means for the resonance module in accordance with the invention will now be summeraly described without specific reference to the drawing figures.

A measuring signal is taken out of either side of the resonance module, one signal being taken out before the module and the other signal after it. Hereinafter the formar signal is designated "reference signal" and the latter" measuring

signal". A first detector sensives the signal and delivers a voltage. If the associated antenna is not given any reference signal, no such signal can be applied to the resonace module and there is thus no voltage either. If a reference signal comes to the resonance module then a measuring signal always occurs sooner or later on the other side of the module, and this signal is sent by a second detector. The detector has a control cercuit, and this is then switched to search state, signifying that the module tuning means preforms a movement in the module and an output signal is sent. When the reference signal and measuring signal have the same phase angle, there is obtained a maximum potential between two applied voltages, which is controlled by the second detector. When there is now measuring signal, the applied voltage has no potential difference. A third detector is arranged for measuring the phase difference between the reference signal and measuring signal, suitably such that either the reference signal or the meassurement signal is phase shifted 90° in relation to the other signal so that an auxiliary signal is obtained. A voltage fed to the circuit will change in size and strength, but due to the phase difference this voltage will be zero in case where there is 90° phase difference between these signals. There will then be phase agreement between the reference signal and meassurement signal. By searching specificly for a zero point in the voltage differences and not a maximum point, anables obtaining a more exact position by achieving a phase difference between the reference signal and measuring signal and using the auxiliary signal thus generated for finding out when phase equality is present. A phase error between the reference and measuring signals gives rise to a proportionally positive or negative error voltage, which after suitable amplification is used to control the adjusting means so that the error goes towards zero.

The apparatus in accordance within the invention is illustrated schematically with the aid of a block diagram in Fig. 1. The base station has a plurality of resonance modules. Each module has its own electrical control curcuit and its own adjusting means. In Fig. 1 there is illustrated the resonance module 1 which has a setting means 3, which reciprocates to and fro a tuning means in the resonance module until the latter means has reached the position where resonance occurs in the module between and input signal and an output signal. The input signal is thus a signal picked up by an antenna and which is to be taken further to a telephone for establishing communication. Hereinafter the incoming signal is designated "reference signal" and comes to the resenance module via an antenna. When the tuning means has set the resonance module to its resonance state, the output signal from it is equal in frequancy with the input signal and can be sent further for telecommunication. Three detectors are arranged for giving signals for operating the setting means 3 via the amplified signals. The first detector is denoted by the numeral 5 and senses the reference signal, and if there is no such signal, no voltage will be sent, signifying that no signal reaches the adjusting means 3. The detector 5 is connected to a comparator 11, a logic curcuit 12 and further to both an error amplifier 8 and a search amplifier 9. A second detector is denoted by the numeral 6 and is designated "amplitude detector". This detector obtains signals in the form of reference signals and measuring signals, i.e. the signals taken out before and after the resonance module. The signals from the amplitude detector go via a comparator and a logical curcuit to the search amplifier 9. A third detector is denoted by the numeral 7 and designated "phase detector". This detector similarly obtains signals in the form of the reference signal and meassurement signal, and this signals are compared and taken to the error amplifier 8. The voltage supply to the apparatus takes place from a batteri via a voltage regulator 13.

The function of the three detectors will now be described with reference to the Figs. 2 and 3. In the circuit diagram of Fig. 2 it will be seen that three detectors are formed round the diod D_1 and the transistors Q_1-Q_6, these detectors being necessary for controlling the associated resonance module in all situation to obtain the resonance frequency at which its transmitter operates. Two signals are required: a reference signal, which is taken out from a point directly before the resonance module, possibly via a direction coupler. A suitably signal level can be said to be about 1 mW. A second signal which, in the following, is thus designated "measuring signal" is taken down from a point after the resonance module, but before its connection with the other modules in the station. A direction coupler is necessary so that inter mixture with other channels will be as small as possible. A suitable level for the measuring signal is also about 1 mW.

If the transmitter is closed down, no searching or frequency adjustment of the resonance module shall be carryed out. The first detector comprices D_1, R_1 and C_1 and gives a voltage at the point A of a minimum of 50 mW when the transmitter is in operation. When the transmitter is closed down the voltage is 0 volt. A time constant R_1, C_1 is selected such that an indication of interrupted transmision can take place for less than 0,5 ms.

The second detector inclodes the transistors Q_2, Q_5 and Q_6.

When transmission is in progress, but there is no measuring signal, the control curcuit must be connected in the search state. Sooner or later a measuring signal will be detected by a detector 2. The output signal will be between the point B_1 and B_2. This signal is used to stop the searching sequence and initiate a fine adjustment of the resonance module, i.e.

its cavity resonance freuquency. The illustrated circuit functions as a selective amplitude detector and is therefore not responsive to the signals of the neighbouring channels. A suitable working point for the transistors Q_1-Q_6 is adjusted with the aid of the resistances R_6, R_8, R_{10}, R_{11} and R_{12}. The illustrated capacitors C_3, C_4 and C_5 are effective HF decoupling capacitors. The measuring signal is supplied to Q_2 and arrives at its base via the coupling capacitor C_6. The resistor R_9 terminates the feed cabel leading the measuring signal with the right impedance to the transistor Q_1. The measuring signal is regained in an amplified state at the collector of the transistor Q_2. This collector current is devided between R_4 and R_5 depending on how the transistors Q_5 and Q_6 are controlled. The reference signal passes the filter C_2. L_1 and is taken via a short cabel to the base of the transistor Q_6. The resistor R_7 terminates the cabel with the right impedance. The reference signal conducts the transistors Q_5 and Q_6 alternatively. If both the reference and the measuring signal have the same phase angle, all current pulses through the transistor Q_2 will be connected to the resistor R_5, with the result that B_1 will be given a high potential while B_2 will be given av low potential.

As will be understood from the description so far an equal voltage of +12 volt will be fed across the parallel resistors R_4 and R_5. If there is no measuring signal, the transistors Q_5 and Q_6 will conduct the same current alternatingly and the voltage drops across the resistors R_4 and R_5 will be equal. There will not be any voltage difference between B_1 and B_2 either. This is illustrated in figure 3 by the graph A.

The resistors R_{15} and R_{16} as well as the capacitor C_9 form a lowpass filter which takes away all remnants of HF from the detector circuit. For the proper function, the requirement of correct phase angle between the reference signal and the

measuring signal is important. This is arranged in the first place by the cables for the respective signals being given a specific length. Fine adjustment then takes place with the capacitor C_2 which with the aid of L_1 can turn the phase about $+45^{\circ}$.

Accordingly when the search according to the above has been stopped with the aid of the detector 2, a third detector takes over and controls the tuning means of the resonance module so that the resonance frequency always agrees with the transmitter signal and that the least possible damping of it is obtained. This third detector is formed by the transistors Q_1, Q_3 and Q_4, which mainly measure the phase difference between the reference and measuring signals. The graph B in figure 3 illustrates the phase sequence as a function of the frequency. Correct tuning takes place when the voltage difference between the F_1 and F_2 is 0 volt. The working point for the transistors in the third detector is determined in the same way and by the same components as for the detector 2. The balanced transistor pair Q_3 and Q_4 are fed with the reference signal, which is here arranged to be at 90° in front of the signal in the detector 2. The cable between the detectors is a quarter of a wavelength long, which gives a phase shift of 90°. The measuring signal, which is amplified in the transistor Q_2, is connected via the capacitor C_7 and transistor Q_1 and appears at its collector shifted 180° in relation to its phase position at the transistor Q_2.The current pulses from the transistor Q_1 are divided by the 90° phase difference equally between the transistor Q_3 and the transistor Q_4. The consequense of this is that the voltage drops across the resistors R_2 and R_3 will be equal and the output voltage between F_1 and F_2 will be zero volts. It will be understood that in the same way as for the signals at B_1 and B_2 the parallel resistors R_1 and R_2 are each fed with

equal voltages of +12 volt. The resistors R_{13} and R_{14} as well as the capacitor C_8 take away the residues of HF and interference signals caused by the neighbouring channels. A phase error between the reference and measuring signals gives rise to a portional positive or negative error voltage, which after suitable amplification is used to control the tuning means in the resonance module so that the error or difference in phase goes towards zero. The capacitor C_2 is used in practice to adjust the entire system to obtain the best tuning result.

As mentioned above, a suitable amplification of the signals from the detectors is arranged to provide the drive to the adjusting means. A terminal drawing of an examplification of an error amplifier is to be found in figure 4. As will be understood, the circuit of figure 4 is connected to that in figure 2 at the points F_1 and F_2. Accordingly, the amplifier circuit according to figure 4 caters for the signals from the detectors at points F_1 and F_2 and with the aid of the adjusting means 3 pulls or pushes the tuning means in the resonance module to its proper position for achieving resonance. The operational speed of the tuning means is a function of the voltage which the amplifier puts across the winding of the adjusting means. In the proposed solution, a stable 6-volt potential is used as a reference voltage for the error amplifier circuit and the adjusting means. This voltage is obtained from the voltage regulator 13, see figure 1. A final step is formed by the transistors Q_7 and Q_8 and has a gain 1 and is capable of supplying all current required by the adjusting means. The error amplifier can operate in three different modes depending on the character of the output signals from the detectors 1 and 2. A logic for the switching is described later, but first there will now be described the different signal paths for the different modes, and with reference to figure 5, 6 and 7. Mode 1 signifies that the

transmitter is shut down and is described in connection with figure 5. Mode 2 signifies that searching is being carried out by the signal and is described in the following together with figure 6. Mode 3 signifies that the signals are being supervised and will be described in connection with figure 7. Switching takes place by three analog switches S_1, S_2 and S_3, see figure 4.

Figure 5 thus shows the signal path in mode 1, i.e. with the transmitter shut down. In this state the adjusting means never moves, i.e. the tuning means is not allowed to move and consequently the adjusting means is never fed with any voltage. If the resistors R_{21}/R_{17} are in the same relationship as the resistors R_{22}/R_{18} and the voltage between F_1 and F_2 is zero, this condition is met. An operation of amplifier IC_1 has a high differential gain and high supression of asymmetrical voltages. If the gain of the error amplifier is low, $R_{21}/R_{17} << 1$, a minor residue voltage between F_1 and F_2 can be tolerated due to the friction in the adjusting means. This friction can also be desirable for keeping the adjusting means resistant to small mecanical vibrations.

Mode 2, the signal searching mode, has its signals illustrated in figure 6. During searching, the tuning means must be driven at a constant rate from one end position to the other and back again. A pneumatic damper, which is built into the adjusting means, garantees a suitable rate at the right voltage across the adjusting means. This voltage changes polarity when the direction is changed. Figure 6 thus illustrates a possible solution to the drive problem. An operational amplifier IC_2 is arranged, and is of the same type as the operational amplifier IC_1 according to figure 5, and amplifies the signal across the adjusting means via a capacitor C_{15} and a resistor R_{27}. The signal is re-fed in positive phase to the input of the operational amplifier IC_1.

The result would be an ascillator, with a frequency determined by the capacitor $C1_5$, resistor R_{26} and the amplitud across the adjusting means. In turn, the amplitude is determined by the resistors R_{24}, R_{25}, R_{23} and R_{21}. Mode 3 is the mode relating to accompanying the signal, and is thus illustrated in figure 7. When the detector 2 senses a signal of the right kind, the circuit round the operational amplifier IC_1 is immediately changed in accordance with what is shown in figure 7. It is then possible for the signal from the detector 2 between F_1 and F_2 to pass through the error amplifier and feed the adjusting means 3 in a phase such that the plunger movement is stopped. A fine adjustment of the position takes place so that the voltage between F_1 and F_2 goes towards zero. It is first here that the circuit justifies its designation of error amplifier. It should be observed that the capacitors C_{13} and C_{14} constitute an interruption for direct current so that the voltage between F_1 and F_2 is amplified in the long run by the entire gain of the operational amplifier IC_1, this gain being about 100.000 times. The components C_{10}, $C_{11}, R_{19}, R_{20}, C_{12}, R_{28}$, R_{29}, C_{13} and C_{14} give a suitable amplitude and phase sequence for different sequences enabling the circuit according to figure 7 to be stable in all situations. The values of the components are determined by a series of factors i.e. the total weight of the tuning means, its tuning range relative its motion, friction, the power of the adjusting means for a given applied voltage, the phase sequence of the resonance cavity, the sensitivity of the detector 3 etc.

There is also a logical switching ciruite for switching between the three previously mentioned modes. The signals from the detectors 1 and 2 must namely be converted to logical levels which are to control the switches S_1, S_2 and S_3. A possible circuit for components for this purpose is illustrated in figure 8. Accordingly, there are two opera-

tional amplifiers IC_3 and IC_4 and these have peripheral components functioning as decision makers for the respective signal. Levels as well as hysteresis are determined by the components round each circuit. At the points D and E, the different signal states can be read off in the form of logical 1's and 0's (high and low level). The operational amplifiers IC_5 and IC_6,IC_7 and IC_8 convert the signals at D and E according to figure 8 to signals for the switches S_1, S_2 and S_3. The components D_4,R_{40} and C_{17} form a delay circuit preventing searching from starting once again for a short overcorrection, i.e. when locking-in. The switches are on when the control voltages are high, i.e. they are 1's.

TABLE OF LEVELS IN THE SWITCHING LOGIC

Mode	D	E	E for DR	S_1,S_2	S_3
Carrier wave from	1	1	1	1	0
Searching	0	1	1	1	1
Accompanying	0	0	0	0	0
Overcorrection	0	1	0	0	0
Distance of carrior wave	1	1	0	1	0

Figure 10 primarily illustrates a resonance module 1. The module contains a cavity with a tuning means 2. Resonance is obtained when the tuning means has adjusted the cavity natural frequency into agreement with an input signal to the cavity. The tuning means 2 is thus moved reciprocally in the cavity in response to which natural frequency desired for the resonance module. Operation of the tuning means 2 takes place by a rod 3 connected to an electromechanical device, which in this case comprises an electromagnet 7 and a coil 6 round the core of the electro magnet. The rod 3 is connected via a stirrup 4 to the coil. The rod has an insulator 5 separating the rod and thus the drive means from the tuning means 2. The coil 6 has two electrical terminals 8 and 9. The tuning means

2 has the form of a metal tongue, e.g. of copper or silver-plated copper and it moves reciprocally in the cavity, which will thus be tuned to different frequencies for different positions of the tuning means in it. An input signal F to the cavity results in an output signal at the same frequency as soon as the natural frequency or resonance frequency of the cavity is equal to that of the input signal.

A servoamplifier 10 sends operation signals to the drive means i.e. to the coil 6 via the terminals 8 and 9. This has been illustrated schematically in figure 1 at the bottom to the right. The control current for the motor is formed by the voltage at the terminal 8, and this voltage can have different potentials or be plus or minus. As soon as the voltage changes or plus is changed to minus, the moving coil 6 will change position and thereby move the rod 3 and metal tongue in the cavity. The servoramplifier 10 is fed by a current with a changing character in response to an input signal M to the servor amplifier. This signal M is generated as explained below.

The output signal E from the resonance module goes to a sensing means 12 and further to an antenna 11. The output signal from the sensing means is a signal KE, which is a constant times E, and this signal is taken to a phase comparison means 13. This means operates at a radio frequency of 900 MHz or 450 MHz. Variations of these frequences are considerable. A signal QS branched off from the input signal 1 is also taken to the phase comparison means. The phases of the signals KE and QS are compared in the phase comparison means 13 which sends the signal M as long as phase difference is present. The signal M is converted in the servoamplifier 10 to control current (voltage) which drives the electrical mechanical drive means 6,7, which in turn moves the tuning means 2 in the cavity in the resonance module 1. The phase of

the output signal KE will thus be changed and the comparison between the signals KE and QS accompany the lower graph in figure 2. When the phase difference is zero, there is resonance in the resonator and the output signal is at a maximum. There is no output signal M from the phase comparison means and the drive means 6,7 stops and the tuning means 2 has arrived at the tuned-in position.

A preferred embodiment of an adjusting means for the tuning means will now be described in connection with figure 9. The tuning means includes a chamber 1 with a tuning means 2 in the form of a metal plunger which is reciprocally movable in a cylinder chamber 3. The plunger 2 is moved with the aid of a means 4. This means comprises a centrally situated iron core 5 in connection with a permanent magnet 6. Outside the iron core an permanent magnet there is an iron ring 7 concentric with these parts and having an annular gap between it and them. An electricly insulating sleev 8 is reciprocally displacable above the iron core 5 and carries a winding. The winding is fed with current wire a very flexibel long wire 9 which is not effected by the displacement of the sleeve 8. In the illustrated embodiment, the metal plunger 2 is carried by an extension 10 of the sleev 8. The extension is mounted on support cushions 11, e.g. of nylon, and these are situated in the region of the central gravity for the system comprising metal plunger, plunger shank and iron core.

In the vicinity of the iron core 5 there is inserted a disc 12, thus forming an air space constituting a damping volyme for the resiprocating movement of the sleev about the iron core 5. The sleeve part 10 can be regarded as a piston rod which can be formed from high frequence-insulating material. Alternatively it can be made from aluminium and the iron core 5 is then preferably quoted with teflon. The line near supplies voltage to the winding for the purpose of driving

the sleeve 8 in either direction on the iron core 5 and for achieving a resonance position for no voltage, when the adjusting means is then inmoveable. The arrangement has the advantage that the adjusting means operates rapidly and the moveing parts have low mutual friction.

The invention also relates to a method of periodacly increasing the number of availably frequencies in a basstation. Each bas station is then equiped with more resonance moduals than the number corresponding to the number of necessary frequencies for normal or low telephonetrafic at the base station for a given period of time. Each resonans module is tunable to the input signal by the tuning means moving in a cavity in the resonance module. If now the number of frequencies of a given bas station needs to be increased due to increasing local trafic intensity, the unoccupate module is tuned to frequencies which are not required in another or other base stations within the area and for the period of time covering the time with increased intensity of the base station in question. When the trafic intensity of the base station in question declines again, the frequencies are then returned to another or other base station to suite the requirements of the trafic intensitive. Tuning is carried out in accordance with the method already described.

By this procedure of loaning out frequencies from different base stations to other base stations there is thus provided the possibility, i.e. in a town area, of letting the base station in the center of the town area to have most of the frequecies during the day time, and many more than individual base stations outside the central area. During the early morning and evening, the base stations in the outer area of the town area require more frequencies to meet the trafic intensity, and frequencies are then transformed from the base station in the town area center to resonance modules in base

stations in the outer areas of the town area. What is required for being able to carry this out is thus that radios signals are used which each give a resonance module notification of what frequency it is to have and that tuning of the resonance module in question can take place rapidly for coming into an agreement with the input signal. The tuning means of the resonance module must thus be operated by a very rapid motor. Such a motor have been described in connection with Fig. 9.

CLAIMS

1. Method in mobile telephone systems including base stations with plurality of resonance module for separately adjusting each resonance module to its own frequecy for receiving and expediting telephone signals on this frequency, a tuning means in each resonance module being guided to its given resonance position in relation to the frequency for incoming signals, c h a r a c t e r i z e d in that the tuning means (2) of the resonance module is operated by an electro mecanical drive means (7) which is connected such as to obtain drive voltage via a phase comparison means, said means being formed such that the drive voltage passes solely when to input signals to the phase comparison means differ in phase, there being connected to the phase comparison means a signal line for a branched signal from an input signal to the resonance module, as well as a signal line carring the output signal from the resonance module (1), such that when both signals are in phase the drive voltage is zero, the drive means is stationary and the tuning means has set the resonance module in resonance with the input signal.

2. Method as claimed in claim 1, c h a r a c t e r i z e d in that the specific input signal to the base station is used as a reference signal and is taken out before the resonance module, in that after this resonance module a measure signal is taken out, in that the reference signal controls, such that when it is present there is a given output voltage (i.e. 50 mV) but for no signal the output voltage is zero, this output voltage being used to decide whether and an adjusting means for the tuning means of the resonance module shall be supplied a voltage with positive or negative protential or not, in that the reference signal and the measure signal are compared with respect to frequency and amplitude so that for

equality a control signal (B_1-B_2) is sent, which is used for interrupting a first searched carried out by the adjusting means when the output voltage responsive to the reference signal so decide, and in that the measuring signal and reference signal are compared with respect to their phases, each phase difference being understod as to its positive or negative direction and is allowed to give rise to positive or negative potential for the voltage driving the adjusting means in a direction such that the measuring signal is changed in phase to that of the reference signal.

3. Method as claimed in claim 1, c h a r a c t e r i z e d in that the determination of the phase difference between the measuring signal and the phase signal is carried out by that either one of the measuring signal or the reference signal being given a phase difference of 90^o to form and auxiliary signal which is used such as when the phase between the auxiliary signal and the signal with the unchanged phase is zero no signal is sent for driving the adjusting means.

4. Means in mobile telephone systems for separately adjusting the resonance module of a base station to its own frequency which is the same as the frequency for a specific signal sent by the base station, a tuning means being controlled by an adjusting means to a position in a cavity so that resonans with the transmitting signal frequency is obtain, c h a r a c t e r i z e d in that the adjusting means of the tuning means is an electromagnetic motor, which have a given directional movement for positive voltage and the reversed direction for negative voltage, said voltage being controlled by three detectors, the first detector of which being signal-connected to the receiving side of the resonance module and for a signal sends a voltage which then determines the amount of drive voltage to the motor, a second detector being signal-connected to the receiving side of the resonance

module and also to the transmitting side of said module, this detector comparing both signals so that when the amplitude is the same a signal is sent which interrupts the drive voltage to the motor, a third detector being signal-connected to the receiving side of the resonance module, and also to the transmitting side of said module for comparing the signals with respect to phase, such that as long as there is a phase difference in one direction (the measuring signal is in front of or after the reference signal), a positive or negative control voltage is sent by the detector for controlling the drive voltage of the motor in corresponding relationship.

5. Apparatus as claimed in claim 1, c h a r a c t e r i z e d in that said third detector contains means for phase-shifting by 90° either the signal from the receiving side of the resonance module or the signal from the transmitting side thereof.

6. Means as claimed in claim 4, c h a r a c t e r i z e d in that the first-mentioned detector includes a diod (d_1) connected to the receiving side of the resonance module, there being a resistor (R_1) and a capacitor (C_1) on the other side of the diod, both of these having their other ends connected to the apparatus ground (earth).

7. Means as claimed in claim 4, c h a r a c t e r i z e d in that the second detector includes a transistor (Q_2) with its base connected to an input of the measuring signal via a coupling capacitor (C_6) to reach the collector of said transistor; a transistor (Q_6) and a transistor (Q_5), the bases of which are connected in parallel via a filter (C_2,L_1) and a short cabel to an input of the reference signal, an equal voltage being fed in parallel to the collectors of said transistors (Q_5,Q_6), the voltage from each collector being taken of via a resistor (R_15 and R_{16}), the transistor (Q_2)

being connected by its collector to both transistors (Q_5,Q_6) so that when the reference signal and measuring signal have the same phase signal, all current passes through the transistor (Q_2) are connected via a resistor (R_4 or R5) to one of the input terminals for said equal voltage, which gives rise to a voltage difference between the voltage output (at B_1,B_2) (via the resistor R_{15} and R_{16}) while for no measuring signal through the transistor (Q_2) the transistors $(Q5,Q_6)$ conduct equally great currents alternatively from the voltage inputs, whereby the voltage diffrent between the voltage outputs (B_1,B_2) will be zero.

8. Means as claimed in claim 4, c h a r a c t e r i z e d in that the third detector includes a transistor (Q_1) which is fed with the measuring signal amplified by the transistor (Q_2) via a capacitor (C_7), the measuring signal being recovered in the collector of the transistor (Q_1) shifted 180^o in relation to the transistor (Q_2) as well as two parallel transistors (Q_3,Q_4) which are supplied with reference signals with a 90^o phase shift relative with the phase in the transistors (Q_5,Q_6) in the second detector by the connection cable between the detectors being a quarter of a wave length, each of the parallel transistors being connected by their collectors to their respective, equal feed voltage via two equal resistors (R_2,R_3), said collectors also having their individual voltage outputs (F_1,F_2) via their individual resistors (R_{13},R_{14}), the transistor (Q_1) being connected by its collector to both transistors (Q_3,Q_4), signifying that the reference signal and measuring signal are compared and give rise either to a voltage difference between the voltage outputs (F_1,F_2) or to no voltage difference.

9. Means as claimed in claim 4, c h a r a c t e r i z e d in that control of the three detectors by the adjusting means is carried out with the aid of an amplifier which receives and amplifies the signals from the three detectors.

10. Means as claimed in claim 4, c h a r a c t e r i z e d in that the adjusting means (4) for the tuning means (1,2) comprises a fixed, sleeve-like part (3), closed at one end, which centrically carries a cylindrical iron core (5) with a permanent magnet (6), about said core (5) there being reciprocately arranged an electricly insulating sleeve (8), carring a winding in the region of the iron core, the other end of the sleeve (in relation to the winding) carring a metal plunger which is reciprocately arranged in a cylidrical chamber (3) associated with the resonances chamber of the tuning means.

11. Means as claimed in claim 10, c h a r a c t e r i z e d in that the metal plunger (2) in carried by the sleeve via a rod piston (10) of high-frequency insulating material.

12. Means as claimed in claim 10, c h a r a c t e r i z e d in that the sleeve (8) has a disc (12) at a given distance from the iron core (5) which defines a given volume in the sleeve towards the iron core.

13. Means as claimed in claim 10 or 11, c h a r a c t e r i - z e d in that the sleeve or the rod piston (10) are carried by support cushions (11), i.e. of nylon, in the region of the center of gravity of the combination metal plunger, sleeve, winding and possible rod piston.

14. Means as claimed in claim 10, c h a r a c t e r i z e d in that the sleeve (8) is formed from aluminium and that the iron core (5) has a coating of teflon.

15. Procedure in the use of the method according to claim 1 in mobile telephone systems, for localy increasing the number of availiable frequencies in base stations within a given area which have been allocated a given number of frequencies,

said base stations being equiped with a plurality of individual, tunable resonance module, c h a r a c t e r i - z e d in that each base station is equiped with more resonance module than the number corresponding to the number of necessary frequencies for normal or low telephone trafic for the base station, in that when a given base station needs to increase its number of frequencies due to increasing local trafic intensity, unoccupied resonance modules are tuned to frequencies which are not needed in one or more other base stations for the period of time covering the time with the increased intensity of the base station in question, and that the reverse takes place afterwards, where by the tuning is carried out by the resonance module in question being supplied with a signal of a given frequency which will control the adjustment of the module such as its resonance frequency will be equal to the frequency of the input signals.

Fig.1

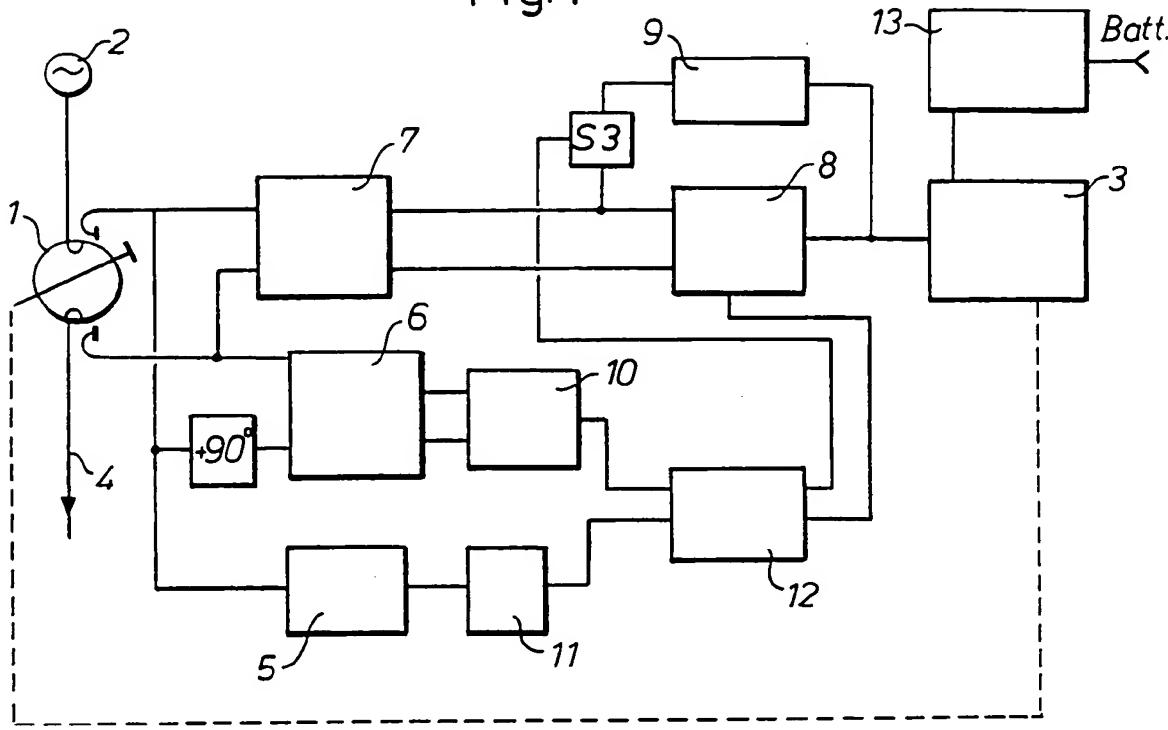
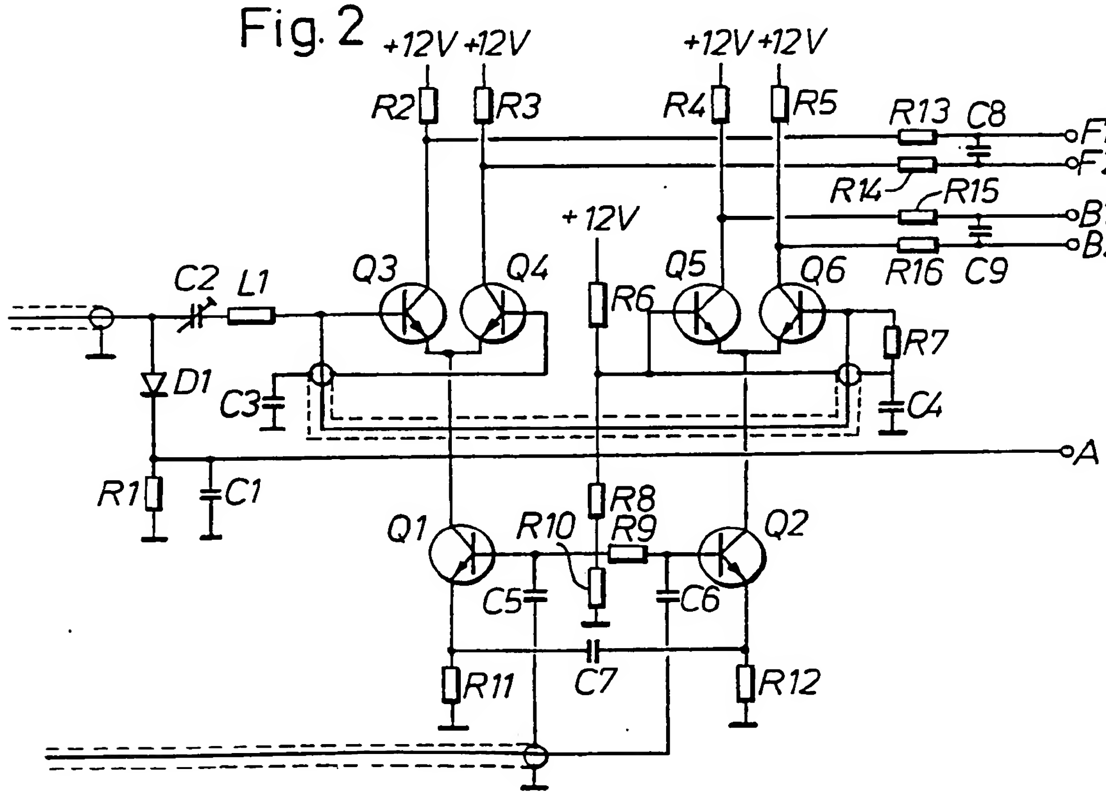

2
1
4
7
6
+90°
10
5
11
S3
9
8
12
13
Batt.
3

Fig. 2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+12V
+12V
+12V
R2
R3
R4
R5
R13
C8
F1
F2
R14
R15
B1
B2
R16
C9
+12V
C2
L1
Q3
Q4
Q5
Q6
R6
R7
D1
C3
C4
A
R1
C1
R8
Q1
R10
R9
Q2
C5
C6
C7
R11
R12

Fig.3

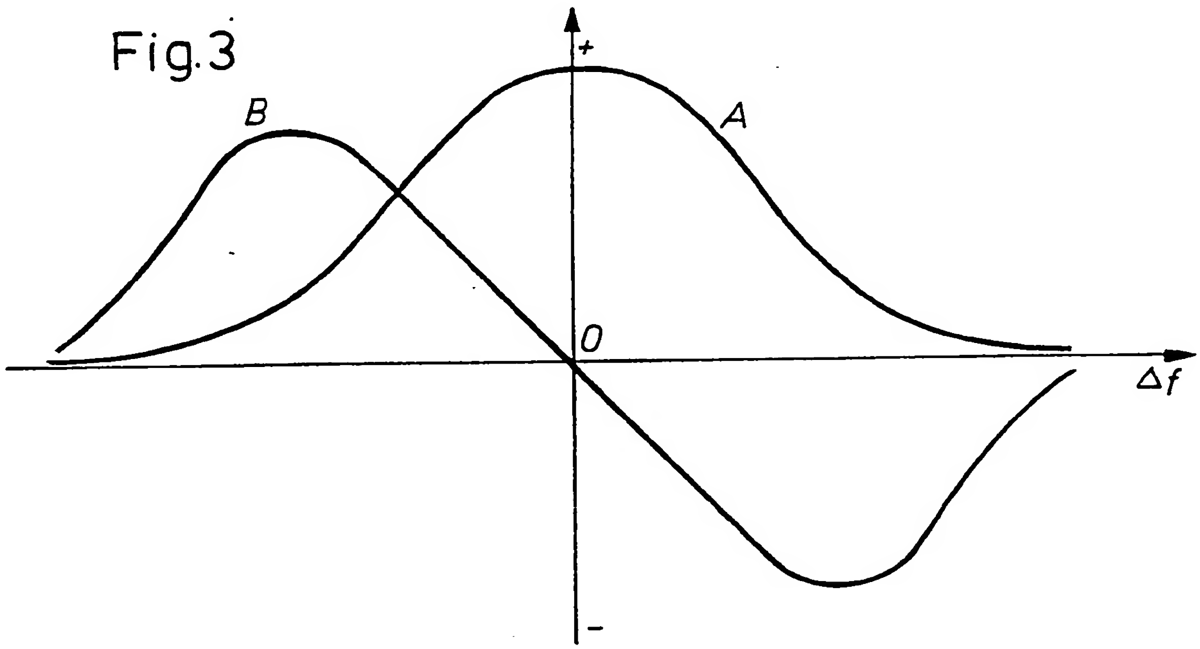
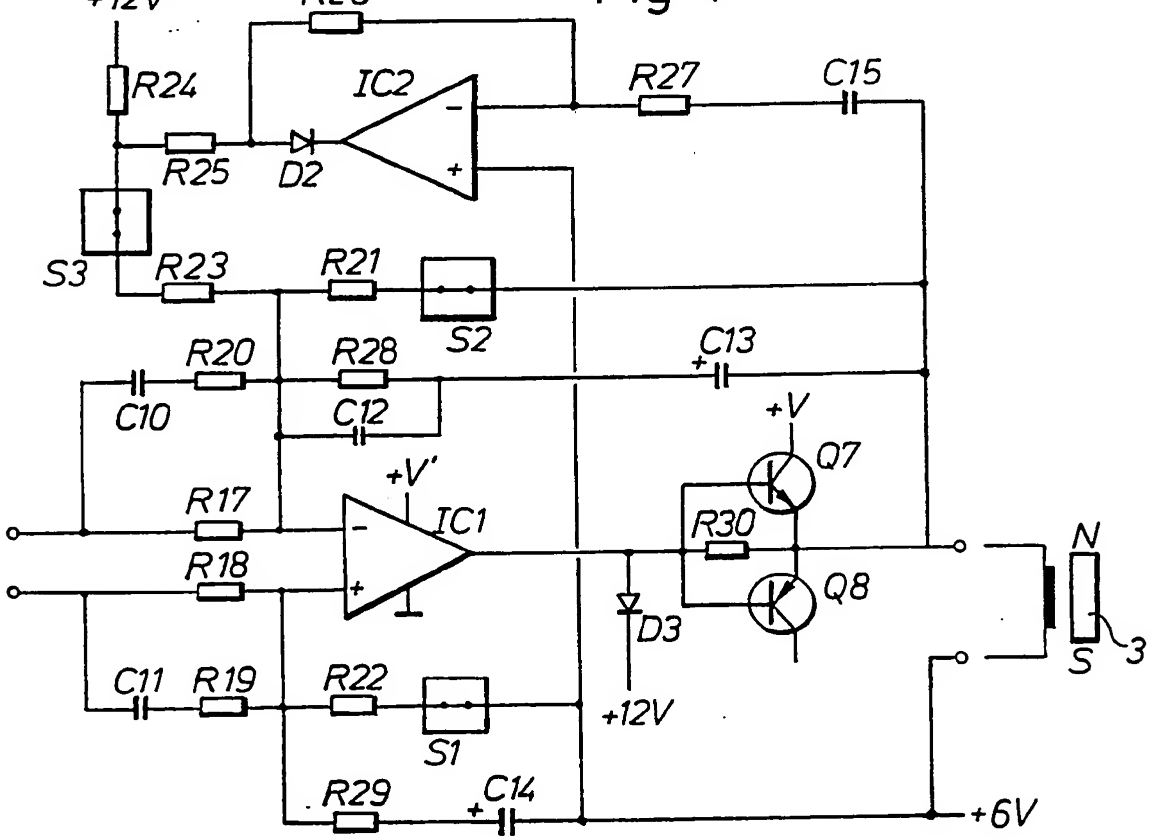

B
A
+
0
Δf
-

Fig. 4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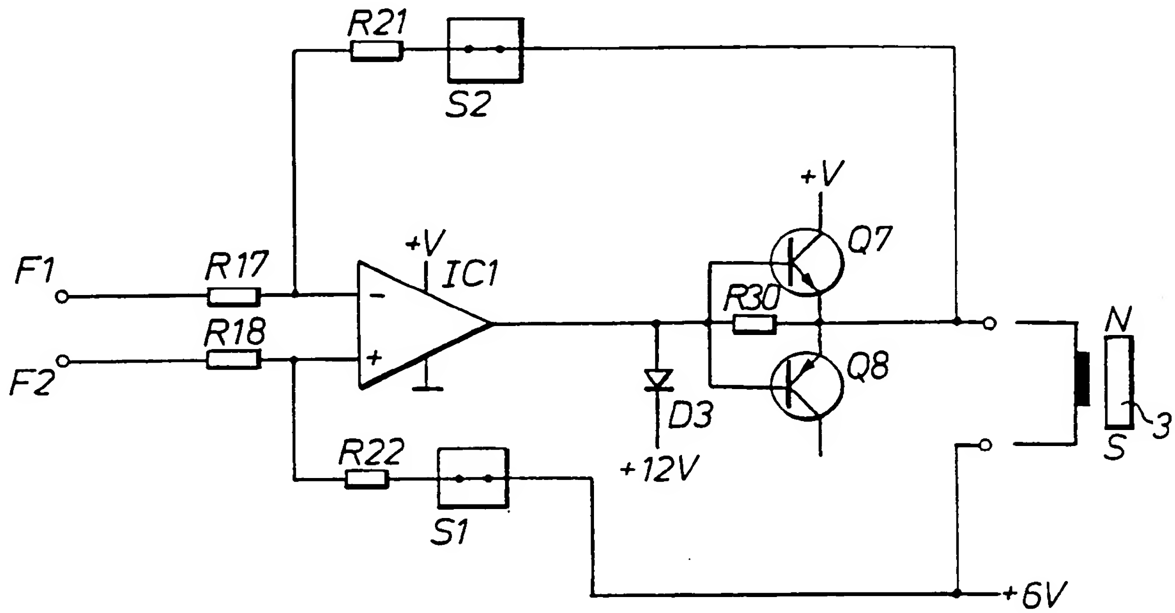
R26
R24
IC2
R27
C15
R25
D2
S3
R23
R21
S2
R20
R28
C13
C10
C12
+V
Q7
+V'
R17
IC1
R30
R18
Q8
N
D3
C11
R19
R22
S1
+12V
S
3
R29
C14
+6V

Fig.5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S2
+V
Q7
F1
R17
+V
IC1
R30
N
R18
F2
Q8
D3
3
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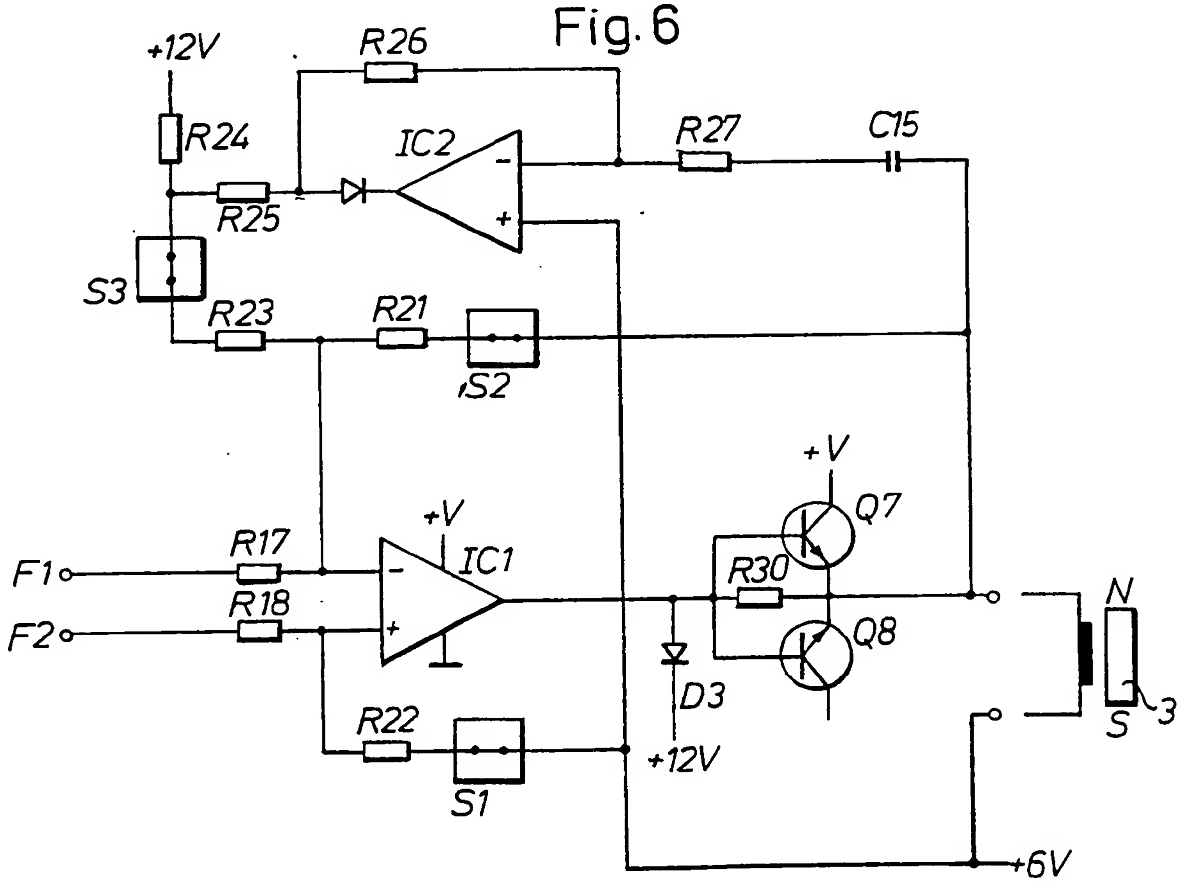
R22
+12V
S1
+6V

Fig. 6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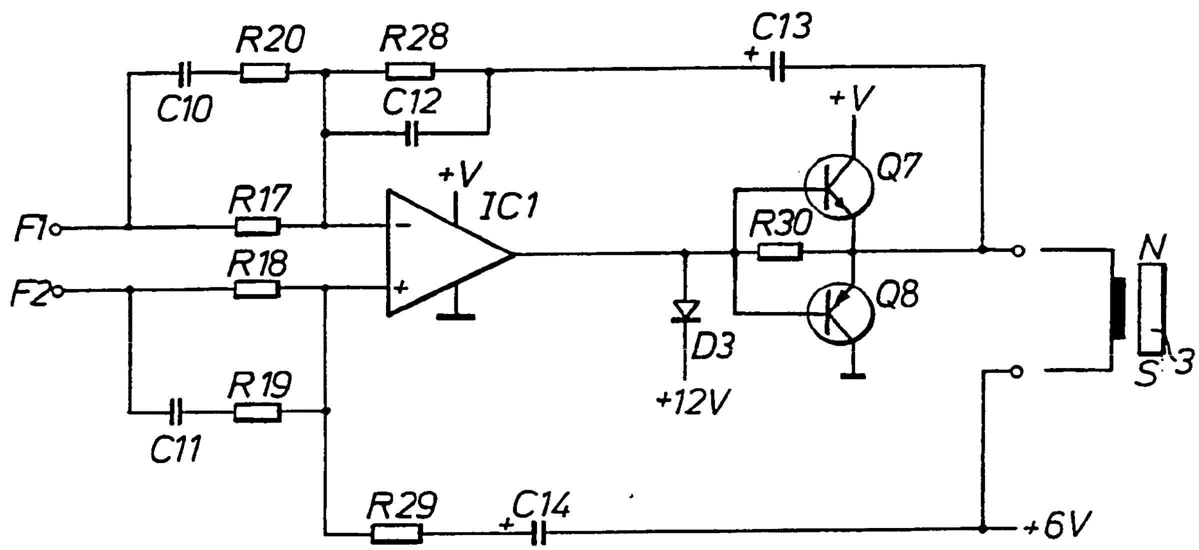
R26
R24
IC2
R27
C15
R25
S3
R23
R21
S2
+V
Q7
+V
R17
IC1
F1
R30
N
F2
R18
Q8
D3
R22
3
S
+12V
S1
+6V

Fig. 7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R20
R28
+V
C10
C12
Q7
+V
IC1
R17
F1
R30
R18
N
F2
Q8
D3
S
3
R19
+12V
C11
R29
C14
+6V

Fig. 8

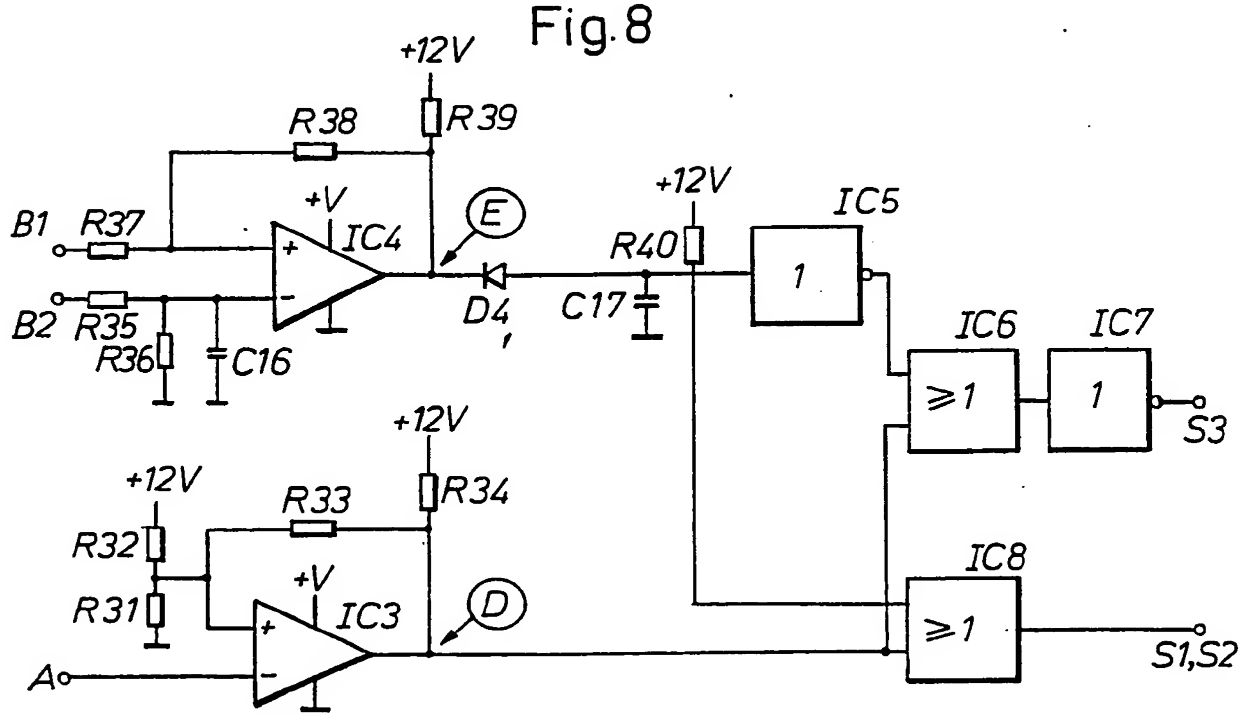

+12V
R38
R39
+12V
IC5
+V
E
B1
R37
IC4
R40
1
D4
C17
B2
R35
IC6
IC7
R36
C16
≥1
1
S3
+12V
R34
+12V
R33
IC8
R32
+V
R31
IC3
D
≥1
A
S1,S2

Fig.9

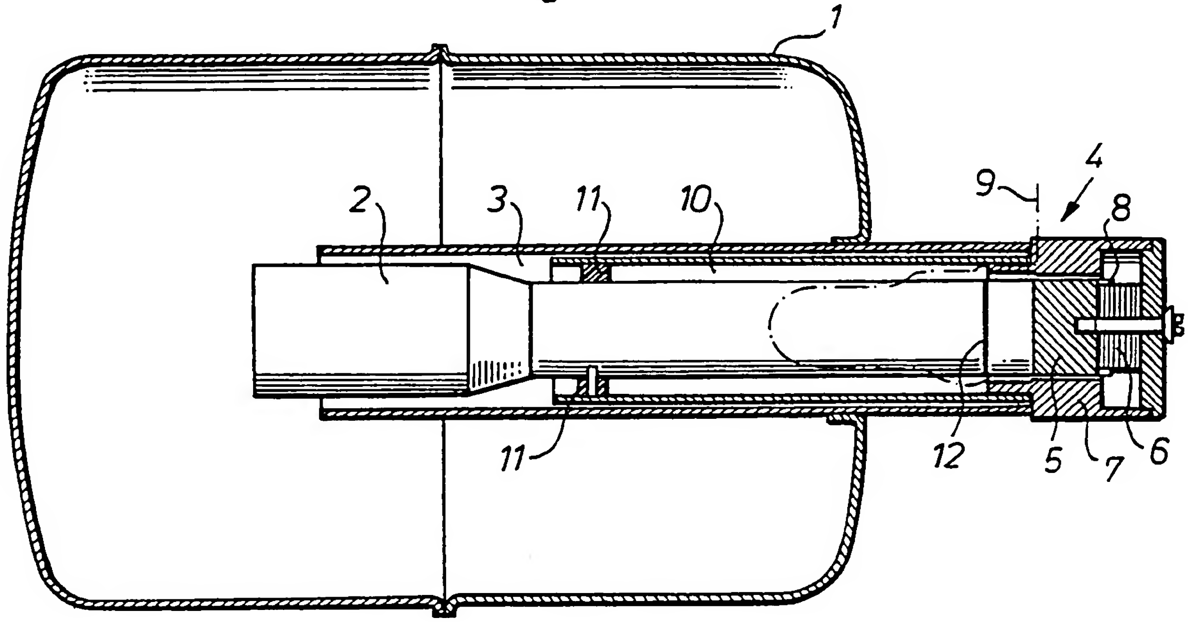
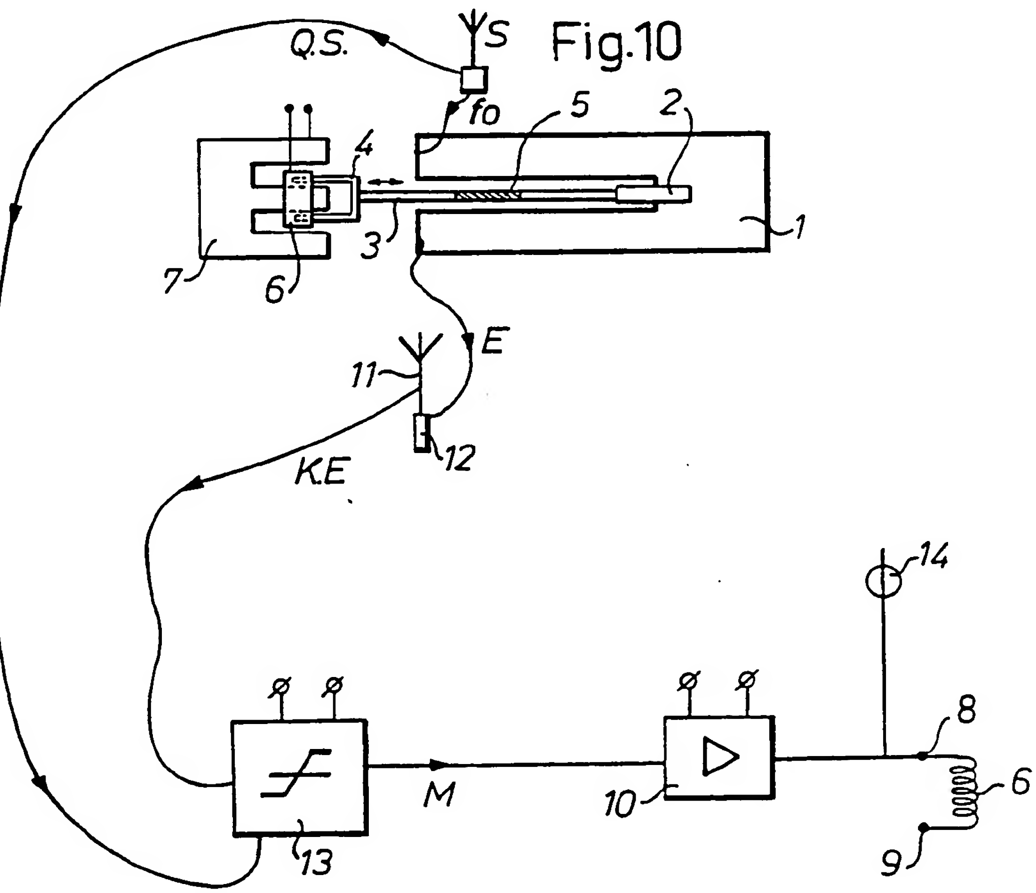


Fig.10



INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 89/00705

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: H 03 J 7/16, H 03 L 7/06

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC5	H 01 P, H 03 B, H 03 J, H 03 L

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [*]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	US, A, 3271684 (A. SIMON) 6 September 1966, see column 1, line 31 - column 2, line 49	1
A	--	2-5
A	EP, A1, 12656 (THOMSON-CSF) 25 June 1980, see page 2, line 27 - page 3, line 28; figure 1 --	1,4
A	US, A, 4726071 (R. JACHOWSKI) 16 February 1988, see column 3, line 53 - column 4, line 62; figure 1 --	1,4

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* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
9th February 1990	1990 -02- 1 5
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Göran Magnusson Göran Magnusson

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. PCT/SE 89/00705

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 3271684	06/09/66	NONE	
EP-A1- 12656	25/06/80	FR-A-B- 2444368	11/07/80
US-A- 4726071	16/02/88	NONE	